

REMARKS

Applicant has added an Abstract to the description as required by 37 CFR 1.72(b).

The rejection of claims 1, 5, 6 and 8 under 35 USC 112, second paragraph, as being indefinite, is respectfully traversed.

Claim 1 has been amended herein by further limiting the separate introduction of hydrogen for the RWGS reaction based on the disclosures of page 7, lines 2-6 and 11-16; the temperature of RWGS reaction based on the disclosures appearing on Reference Examples 3 and 5 of pages 9 and 11; and the component of the catalyst used in RWGS reaction based on page 5, lines 4-6 and from claim 3.

In addition, claim 2 has been deleted; claims 3 and 4 have been amended to depend from claim 1; claims 5-7 have been cancelled; claim 8 has been redrafted as an independent claim, and claim 10 has been added as a new dependent claim dependent from claim 8. Claim 8 is similar to claim 1 except for the oxide catalyst which, in claim 8 is NiO, with the reaction carried out between 700 to 900 °C.

Accordingly, the rejection of claims 1, 5, 6 and 8 under 35 USC 112 should be withdrawn.

The rejection of claims 1-9 under 35 USC 103(a) as being unpatentable over Pagani (USP 4,098,809) in view of Wang et al. (US 2003/0162846 A1), Dupont et al. (US 2003/0113244 A1) and Krylov et al., is respectfully traversed.

The subject invention is characterized in that a large amount of carbon dioxide ( $\text{CO}_2$ ) gas generated during the process for direct production of DME is converted back to carbon monoxide (CO) via a reverse water gas shift (RWGS) reaction under a specified condition, and said CO is recycled to the DME production process, thus increasing the yield of DME while lowering the amount of carbon dioxide discharged. The adaptation of RWGS in the process for the direct production of DME according to the subject invention cannot be easily derived from the combination of the techniques known in the art, as explained below.

As recognized by the Examiner, the difference between the subject invention and the Pagani patent, cited as a primary reference, is that the Pagani patent fails to disclose converting  $\text{CO}_2$  into CO using hydrogen in a reverse water gas shift (RWGS) reactor and recycling the CO rich stream to the DME synthesis step. In this regard, the Examiner mentioned that Wang et al. disclose the use of RWGS reaction for the synthesis of CO gas, Dupont et al. teach the production of CO by RWGS reaction in the presence of  $\text{ZnO}$  and  $\text{NiO}$  over chromium oxide, and Krylov et al. teach the use of  $\text{CaO}$ ,  $\text{MnO}$  over  $\text{Al}_2\text{O}_3$ . The Examiner alleges that it is obvious from the combination of the DME process of Pagani with the syn gas

production of Wang et al. and Dupont et al. and the catalyst of Krylov et al. to practice the method of the subject invention.

In this regard, the Examiner should at first note that the RWGS reaction disclosed by Wang et al. is intended to convert CO<sub>2</sub>, produced together with hydrogen (H<sub>2</sub>) and CO in a synthesis gas generation through methane reforming process, into CO (see page 3, paragraph [0029] to [0033]). Thus, a high temperature up to 1200 °C is required to convert CO<sub>2</sub> into CO, because the RWGS reaction is an equilibrium reaction. Accordingly, Wang et al. comprises a step of additionally introducing CO<sub>2</sub> (see page 6, Table 1, Streams 20 and 22, and Fig. 1), instead of a step of introducing hydrogen separately to be reacted with CO<sub>2</sub> as claimed in the present invention. Further, Wang et al. is silent on the specific conditions in the RWGS reaction.

Further, with respect to the conditions for the RWGS reaction, the subject invention employs as a catalyst for the RWGS reaction a catalyst system of a ZnO-based oxide such as ZnO/Al<sub>2</sub>O<sub>3</sub>, ZnO/ZrO<sub>2</sub>, ZnO/MgO or ZnO/SiO<sub>2</sub>, or a NiO-based oxide such as NiO/Al<sub>2</sub>O<sub>3</sub>, NiO/ZrO<sub>2</sub>, NiO/MgO or NiO/SiO<sub>2</sub>, or a mixture thereof, whereas Dupont et al. teach ZnO and NiO supported on chromium oxide (Cr<sub>2</sub>O<sub>3</sub>), which has a lower thermal stability than that of the catalysts of the subject invention at a temperature higher than 500 °C. Thus, the catalyst systems of the subject invention and the Dupont et al. are clearly different, and, due to this difference, the subject invention and Dupont et al. are different from each other in

terms of the temperature for the RWGS reaction. That is, Dupont et al. conducted the RWGS reaction at a relatively low temperature of 300-520 °C, preferably 300-500 °C, more preferably 300-450 °C (see paragraphs [0022] and [0131]), whereas the subject invention mandates a relatively high temperature of either between 500-900 °C or 700-900 °C, in case of ZnO- and NiO-based catalyst systems, respectively.

Furthermore, CaO or MnO supported on Al<sub>2</sub>O<sub>3</sub>, as disclosed in Krylov et al., is a catalyst for reforming methane, not for an RWGS reaction, and the active ingredient is entirely different from ZnO or NiO according to the subject invention.

Accordingly, it is clear that the subject invention as recited in amended claim 1 is clearly patentable over the combination of the cited primary and secondary references.

Reconsideration and allowance of claims 1, 3, 4 and 8-10 is  
respectfully solicited.

Respectfully submitted,  
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I hereby certify that this AMENDMENT is being deposited with the Commissioner For Patents, P.O. Box 1450, Alexandria, VA 22313-1450 via EFS-Web on March 14, 2008.

Signed: Audrey de Souza  
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